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(54) Title: METHOD AND APPARATUS FOR SELECTING AN ENCODING RATE IN A VARIABLE RATE VOCODER
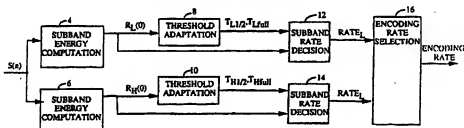
(57) Abstract

The present invention provides a method by which to reduce the probality of coding low energy unvoiced speech as background noise. An encoding rate is determined by dividing the input signal into subbands using digital subband filters (4) and (6) and comparing the energy in those bands to a set of thresholds in subband rate decision elements (12) and (14) and then examining those comparisons in an encoding rate selector (16). By this method, unvoiced speech can be distinguished from background noise. The present invention, also, provides a means for setting the threshold levels using the signal to noise ratio of the input signal, and the present invention provides a method for coding music through a variable rate vocoder by examining the periodicity of the input signal to distinguish the music from background noise.

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METHOD AND APPARATUS FOR SELECTING AN ENCODING RATE IN A VARIABLE RATE VOCODER

BACKGROUND OF THE INVENTION

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I. Field of the Invention

The present invention relates to vocoders. More particularly, the present invention relates to a novel and improved method for determining
10   speech encoding rate in a variable rate vocoder.

II. Description of the Related Art

Variable rate speech compression systems typically use some form of
15   rate determination algorithm before encoding begins.   The rate determination algorithm assigns a higher bit rate encoding scheme to segments of the audio signal in which speech is present and a lower rate encoding scheme for silent segments.   In this way a lower average bit rate will be achieved while the voice quality of the reconstructed speech will
20   remain high.   Thus to operate efficiently a variable rate speech coder requires a robust rate determination algorithm that can distinguish speech from silence in a variety of background noise environments.

One such variable rate speech compression system or variable rate vocoder is disclosed in copending U.S. Patent Application Serial No.
25   07/713,661 filed June 11, 1991, entitled "Variable Rate Vocoder" and assigned to the assignee of the present invention, the disclosure of which is incorporated by reference. In this particular implementation of a variable rate vocoder, input speech is encoded using Code Excited Linear Predictive Coding (CELP) techniques at one of several rates as determined by the level
30   of speech activity. The level of speech activity is determined from the energy in the input audio samples which may contain background noise in addition to voiced speech. In order for the vocoder to provide high quality voice encoding over varying levels of background noise, an adaptively adjusting threshold technique is required to compensate for the affect of
35   background noise on the rate decision algorithm.

Vocoders are typically used in communication devices such as cellular telephones or personal communication devices to provide digital signal compression of an analog audio signal that is converted to digital form for transmission.   In a mobile environment in which a cellular
40   telephone or personal communication device may be used, high levels of

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background noise energy make it difficult for the rate determination algorithm to distinguish low energy unvoiced sounds from background noise silence using a signal energy based rate determination algorithm. Thus unvoiced sounds frequently get encoded at lower bit rates and the
5 voice quality becomes degraded as consonants such as "s","x","ch","sh","t", etc. are lost in the reconstructed speech.

Vocoders that base rate decisions solely on the energy of background noise fail to take into account the signal strength relative to the background noise in setting threshold values. A vocoder that bases its threshold levels
10 solely on background noise tends to compress the threshold levels together when the background noise rises. If the signal level were to remain fixed this is the correct approach to setting the threshold levels, however, were the signal level to rise with the background noise level, then compressing the threshold levels is not an optimal solution. An alternative method for
15 setting threshold levels that takes into account signal strength is needed in variable rate vocoders.

A final problem that remains arises during the playing of music through background noise energy based rate decision vocoders. When people speak, they must pause to breathe which allows the threshold levels
20 to reset to the proper background noise level. However, in transmission of music through a vocoder, such as arises in music-on-hold conditions, no pauses occur and the threshold levels will continue rising until the music starts to be coded at a rate less than full rate. In such a condition the variable rate coder has confused music with background noise.
25

SUMMARY OF THE INVENTION

The present invention is a novel and improved method and apparatus for determining an encoding rate in a variable rate vocoder. It is a
30 first objective of the present invention to provide a method by which to reduce the probability of coding low energy unvoiced speech as background noise. In the present invention, the input signal is filtered into a high frequency component and a low frequency component. The filtered components of the input signal are then individually analyzed to detect the
35 presence of speech. Because unvoiced speech has a high frequency component its strength relative to a high frequency band is more distinct from the background noise in that band than it is compared to the background noise over the entire frequency band.

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A second objective of the present invention is to provide a means by which to set the threshold levels that takes into account signal energy as well as background noise energy. In the present invention, the setting of voice detection thresholds is based upon an estimate of the signal to noise

5   ratio (SNR) of the input signal. In the exemplary embodiment, the signal energy is estimated as the maximum signal energy during times of active speech and the background noise energy is estimated as the minimum signal energy during times of silence.

A third objective of the present invention is to provide a method for

10 coding music passing through a variable rate vocoder. In the exemplary embodiment, the rate selection apparatus detects a number of consecutive frames over which the threshold levels have risen and checks for periodicity over that number of frames. If the input signal is periodic this would indicate the presence of music. If the presence of music is detected

15 then the thresholds are set at levels such that the signal is coded at full rate.

BRIEF DESCRIPTION OF THE DRAWINGS

The features, objects, and advantages of the present invention will

20 become more apparent from the detailed description set forth below when taken in conjunction with the drawings in which like reference characters identify correspondingly throughout and wherein:

Figure 1 is a block diagram of the present invention.

25   ## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to Figure 1 the input signal, $S(n)$, is provided to subband energy computation element 4 and subband energy computation element 6.

30 The input signal $S(n)$ is comprised of an audio signal and background noise. The audio signal is typically speech, but it may also be music. In the exemplary embodiment, $S(n)$ is provided in twenty millisecond frames of 160 samples each. In the exemplary embodiment, input signal $S(n)$ has frequency components from 0 kHz to 4 kHz, which is approximately the

35 bandwidth of a human speech signal.

In the exemplary embodiment, the 4 kHz input signal, $S(n)$, is filtered into two separate subbands. The two separate subbands lie between 0 and 2 kHz and 2 kHz and 4 kHz respectively. In an exemplary embodiment, the input signal may be divided into subbands by subband filters, the design of

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which are well known in the art and detailed in U.S. Patent Application Serial No. 08/189,819 filed February 1, 1994, entitled "Frequency Selective Adaptive Filtering", and assigned to the assignee of the present invention, incorporated by reference herein.

5   The impulse responses of the subband filters are denoted $h_L(n)$, for the lowpass filter, and $h_H(n)$, for the highpass filter. The energy of the resulting subband components of the signal can be computed to give the values $R_L(0)$ and $R_H(0)$, simply by summing the squares of the subband filter output samples, as is well known in the art.

10   In a preferred embodiment, when input signal $S(n)$ is provided to subband energy computation element 4, the energy value of the low frequency component of the input frame, $R_L(0)$, is computed as:

$$R_L(0) = R_S(0) \cdot R_{h_L}(0) + 2 \cdot \sum_{i=1}^{L-1} R_S(i) \cdot R_{h_L}(i), \tag{1}$$

15 where L is the number taps in the lowpass filter with impulse response $h_L(n)$,
where $R_S(i)$ is the autocorrelation function of the input signal, $S(n)$, given by the equation:

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$$R_S(i) = \sum_{n=1}^{N} S(n) \cdot S(n-i), \qquad \text{for } i \in [0, L-1] \tag{2}$$

where N is the number of samples in the frame,
and where R_{hL} is the autocorrelation function of the lowpass filter $h_L(n)$
25 given by:

$$R_{h_L}(i) = \sum_{n=0}^{L-1} h_L(n) \cdot h_L(n-i). \qquad \text{for } i \in [0, L-1] \tag{3}$$
$$= 0 \qquad\qquad\qquad \text{else}$$

30 The high frequency energy, $R_H(0)$, is computed in a similar fashion in subband energy computation element 6.
     The values of the autocorrelation function of the subband filters can be computed ahead of time to reduce the computational load. In addition, some of the computed values of $R_S(i)$ are used in other computations in the

coding of the input signal, $S(n)$, which further reduces the net computational burden of the encoding rate selection method of the present invention. For example, the derivation of LPC filter tap values requires the computation of a set of input signal autocorrelation coefficients.

The computation of LPC filter tap values is well known in the art and is detailed in the abovementioned U.S. Patent Application 08/004,484. If one were to code the speech with a method requiring a ten tap LPC filter only the values of $R_S(i)$ for i values from 11 to L-1 need to be computed, in addition to those that are used in the coding of the signal, because $R_S(i)$ for i values from 0 to 10 are used in computing the LPC filter tap values. In the exemplary embodiment, the subband filters have 17 taps, L=17.

Subband energy computation element 4 provides the computed value of $R_L(0)$ to subband rate decision element 12, and subband energy computation element 6 provides the computed value of $R_H(0)$ to subband rate decision element 14. Rate decision element 12 compares the value of $R_L(0)$ against two predetermined threshold values $T_{L1/2}$ and T_{Lfull} and assigns a suggested encoding rate, $RATE_L$, in accordance with the comparison. The rate assignment is conducted as follows:

$$RATE_L = \text{eighth rate} \qquad R_L(0) \leq T_{L1/2} \qquad (4)$$
$$RATE_L = \text{half rate} \qquad T_{L1/2} < R_L(0) \leq T_{Lfull} \qquad (5)$$
$$RATE_L = \text{full rate} \qquad R_L(0) > T_{Lfull} \qquad (6)$$

Subband rate decision element 14 operates in a similar fashion and selects a suggest encoding rate, $RATE_H$, in accordance with the high frequency energy value $R_H(0)$ and based upon a different set of threshold values $T_{H1/2}$ and T_{Hfull}. Subband rate decision element 12 provides its suggested encoding rate, $RATE_L$, to encoding rate selection element 16, and subband rate decision element 14 provides its suggested encoding rate, $RATE_H$, to encoding rate selection element 16. In the exemplary embodiment, encoding rate selection element 16 selects the higher of the two suggest rates and provides the higher rate as the selected ENCODING RATE.

Subband energy computation element 4 also provides the low frequency energy value, $R_L(0)$, to threshold adaptation element 8, where the threshold values $T_{L1/2}$ and T_{Lfull} for the next input frame are computed. Similarly, subband energy computation element 6 provides the high frequency energy value, $R_H(0)$, to threshold adaptation element 10, where the threshold values $T_{H1/2}$ and T_{Hfull} for the next input frame are computed.

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Threshold adaptation element 8 receives the low frequency energy value, $R_L(0)$, and determines whether $S(n)$ contains background noise or audio signal. In an exemplary implementation, the method by which threshold adaptation element 8 determines if an audio signal is present is by examining the normalized autocorrelation function NACF, which is given by the equation:

$$NACF = \max_{T} \frac{\sum\limits_{n=0}^{N-1} e(n) \cdot e(n-T)}{\frac{1}{2} \cdot \left[\sum\limits_{n=0}^{N-1} e^2(n) + \sum\limits_{n=0}^{N-1} e^2(n-T) \right]}, \qquad (7)$$

where $e(n)$ is the formant residual signal that results from filtering the input signal, $S(n)$, by an LPC filter.

The design of and filtering of a signal by an LPC filter is well known in the art and is detailed in aforementioned U.S. Patent Application 08/004,484. The input signal, $S(n)$ is filtered by the LPC filter to remove interaction of the formants. NACF is compared against a threshold value to determine if an audio signal is present. If NACF is greater than a predetermined threshold value, it indicates that the input frame has a periodic characteristic indicative of the presence of an audio signal such as speech or music. Note that while parts of speech and music are not periodic and will exhibit low values of NACF, background noise typically never displays any periodicity and nearly always exhibits low values of NACF.

If it is determined that $S(n)$ contains background noise, the value of NACF is less than a threshold value TH1, then the value $R_L(0)$ is used to update the value of the current background noise estimate BGN_L. In the exemplary embodiment, TH1 is 0.35. $R_L(0)$ is compared against the current value of background noise estimate BGN_L. If $R_L(0)$ is less than BGN_L, then the background noise estimate BGN_L is set equal to $R_L(0)$ regardless of the value of NACF.

The background noise estimate BGN_L is only increased when NACF is less than threshold value TH1. If $R_L(0)$ is greater than BGN_L and NACF is less than TH1, then the background noise energy BGN_L is set $\alpha_1 \cdot BGN_L$, where α_1 is a number greater than 1. In the exemplary embodiment, α_1 is equal to 1.03. BGN_L will continue to increase as long as NACF is less than threshold value TH1 and $R_L(0)$ is greater than the current value of BGN_L,

until BGN$_L$ reaches a predetermined maximum value BGN$_{max}$ at which
point the background noise estimate BGN$_L$ is set to BGN$_{max}$.

If an audio signal is detected, signified by the value of NACF
exceeding a second threshold value TH2, then the signal energy estimate,
S$_L$, is updated. In the exemplary embodiment, TH2 is set to 0.5. The value
of R$_L$(0) is compared against a current lowpass signal energy estimate, S$_L$. If
R$_L$(0) is greater than the current value of S$_L$, then S$_L$ is set equal to R$_L$(0). If
R$_L$(0) is less than the current value of S$_L$, then S$_L$ is set equal to $\alpha_2 \cdot S_L$, again
only if NACF is greater than TH2. In the exemplary embodiment, α_2 is set
to 0.96.

Threshold adaptation element 8 then computes a signal to noise ratio
estimate in accordance with equation 8 below:

$$SNR_L = 10 \cdot \log\left[\frac{S_L}{BGN_L}\right] \qquad\qquad (8)$$

Threshold adaptation element 8 then determines an index of the quantized
signal to noise ratio I$_{SNRL}$ in accordance with equation 9-12 below:

$$I_{SNRL} = \text{nint}\left[\frac{SNR_L - 20}{5}\right], \qquad \text{for } 20 < SNR_L < 55, \qquad (9)$$

$$= 0, \qquad\qquad \text{for } SNR_L \leq 20, \qquad (10)$$
$$= 7 \qquad\qquad \text{for } SNR_L \geq 55.$$

where nint is a function that rounds the fractional value to the nearest
integer.

Threshold adaptation element 8, then selects or computes two scaling
factors, k$_{L1/2}$ and k$_{Lfull}$, in accordance with the signal to noise ratio index,
I$_{SNRL}$. An exemplary scaling value lookup table is provided in table 1
below:

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TABLE 1

I_{SNRL}	$K_{L1/2}$	K_{Lfull}
0	7.0	9.0
1	7.0	12.6
2	8.0	17.0
3	8.6	18.5
4	8.9	19.4
5	9.4	20.9
6	11.0	25.5
7	15.8	39.8

These two values are used to compute the threshold values for rate
selection in accordance with the equations below:

$$T_{L1/2} = K_{L1/2} \cdot BGN_L, \text{ and} \tag{11}$$

$$T_{Lfull} = K_{Lfull} \cdot BGN_L, \tag{12}$$

where $T_{L1/2}$ is low frequency half rate threshold value and
T_{Lfull} is the low frequency full rate threshold value.

Threshold adaptation element 8 provides the adapted threshold values
$T_{L1/2}$ and T_{Lfull} to rate decision element 12. Threshold adaptation element
10 operates in a similar fashion and provides the threshold values $T_{H1/2}$
and T_{Hfull} to subband rate decision element 14.

The initial value of the audio signal energy estimate S, where S can be
S_L or S_H, is set as follows. The initial signal energy estimate, S_{INIT}, is set to
-18.0 dBm0, where 3.17 dBm0 denotes the signal strength of a full sine wave,
which in the exemplary embodiment is a digital sine wave with an
amplitude range from -8031 to 8031. S_{INIT} is used until it is determined
that an acoustic signal is present.

The method by which an acoustic signal is initially detected is to
compare the NACF value against a threshold, when the NACF exceeds the
threshold for a predetermined number consecutive frames, then an acoustic
signal is determined to be present. In the exemplary embodiment, NACF
must exceed the threshold for ten consecutive frames. After this condition
is met the signal energy estimate, S, is set to the maximum signal energy in
the preceding ten frames.

The initial value of the background noise estimate BGN_L is initially
set to BGN_{max}. As soon as a subband frame energy is received that is less

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than BGN_{max}, the background noise estimate is reset to the value of the
received subband energy level, and generation of the background noise
BGN_L estimate proceeds as described earlier.

In a preferred embodiment a hangover condition is actuated when
following a series of full rate speech frames, a frame of a lower rate is
detected. In the exemplary embodiment, when four consecutive speech
frames are encoded at full rate followed by a frame where
ENCODING RATE is set to a rate less than full rate and the computed signal
to noise ratios are less than a predetermined minimum SNR, the
ENCODING RATE for that frame is set to full rate. In the exemplary
embodiment the predetermined minimum SNR is 27.5 dBas defined in
equation 8.

In the preferred embodiment, the number of hangover frames is a
function of the signal to noise ratio. In the exemplary embodiment, the
number of hangover frames is determined as follows:

$$\#hangover\ frames = 1 \qquad 22.5 < SNR < 27.5, \qquad (13)$$
$$\#hangover\ frames = 2 \qquad SNR \le 22.5, \qquad (14)$$
$$\#hangover\ frames = 0 \qquad SNR \ge 27.5. \qquad (15)$$

The present invention also provides a method with which to detect
the presence of music, which as described before lacks the pauses which
allow the background noise measures to reset. The method for detecting the
presence of music assumes that music is not present at the start of the call.
This allows the encoding rate selection apparatus of the present invention
to properly estimate and initial background noise energy, BGN_{init}. Because
music unlike background noise has a periodic characteristic, the present
invention examines the value of NACF to distinguish music from
background noise. The music detection method of the present invention
computes an average NACF in accordance with the equation below:

$$NACF_{AVE} = \frac{1}{T}\sum_{i=1}^{T} NACF(i), \qquad (16)$$

where NACF is defined in equation 7, and
where T is the number of consecutive frames in which the estimated value
of the background noise has been increasing from an initial background
noise estimate BGN_{INIT}.

If the background noise BGN has been increasing for the predetermined number of frames T and $NACF_{AVE}$ exceeds a predetermined threshold, then music is detected and the background noise
5   BGN is reset to BGN_{init}. It should be noted that to be effective the value T must be set low enough that the encoding rate doesn't drop below full rate. Therefore the value of T should be set as a function of the acoustic signal and BGN_{init}.

The previous description of the preferred embodiments is provided
10 to enable any person skilled in the art to make or use the present invention. The various modifications to these embodiments will be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other embodiments without the use of the inventive faculty. Thus, the present invention is not intended to be limited to the
15 embodiments shown herein but is to be accorded the widest scope consistent with the principles and novel features disclosed herein.

WE CLAIM:

CLAIMS

1.   An apparatus for determining an encoding rate for a variable
rate vocoder comprising:
        subband energy computation means for receiving an input signal and
determining a plurality of subband energy values in accordance with a
predetermined subband energy computation format;
        rate determination means for receiving said plurality of subband
energy values and determining said encoding rate in accordance with said
plurality of subband energy values.

2.   The apparatus of Claim 1 wherein said subband energy
computation means determines each of said plurality of subband energy
values in accordance with the equation:

$$\text{subband energy} = R_S(0) \cdot R_{h_{bp}}(0) + 2 \cdot \sum_{i=1}^{L-1} R_S(i) \cdot R_{h_{bp}}(i),$$

where L is the number taps in the lowpass filter $h_L(n)$,
where $R_S(i)$ is the autocorrelation function of the input signal, $S(n)$, and
where R_{hL} is the autocorrelation function of a bandpass filter $h_{bp}(n)$.

3.   The apparatus of Claim 1 further comprising threshold
computation means disposed between said subband energy computation
means and said rate determination means for receiving said subband energy
values and for determining a set of encoding rate threshold values in
accordance with plurality of subband energy values.

4.   The apparatus of Claim 3 wherein said threshold computation
means determines a signal to noise ratio value in accordance with said
plurality of subband energy values.

5.   The apparatus of Claim 4 wherein said threshold computation
means determines a scaling value in accordance with said signal to noise
ratio value.

6.   The apparatus of Claim 5 wherein threshold computation
means determines at least one threshold value by multiplying a background
noise estimate by said scaling value.

7. The apparatus of Claim 1 wherein said rate determination
2 compares at least one of said plurality of subband energy values with at least
one threshold value to determine said encoding rate.

8. The apparatus of Claim 6 wherein said rate determination
2 means compares at least one of said plurality of subband energy values with
said at least one threshold value to determine said encoding rate.

9. The apparatus of Claim 1 wherein said rate determination
2 means determines a plurality of suggested encoding rates wherein each
suggested encoding rate corresponds to each of said plurality of subband
4 energy values and wherein said rate determination means determines said
encoding rate in accordance with said plurality of suggested encoding rates.

10. An apparatus for determining an encoding rate for a variable
2 rate vocoder comprising:
signal to noise ratio means for receiving an input signal and
4 determining a signal to noise ratio value in accordance with said input
signal;
6 rate determination means for receiving said signal to noise ratio
value and determining said encoding rate in accordance with said signal to
8 noise ratio value.

11. An apparatus for determining an encoding rate for a variable
2 rate vocoder comprising:
a subband energy calculator that receives an input signal and
4 determines a plurality of subband energy values in accordance with a
predetermined subband energy computation format;
6 a rate selector that receives said plurality of subband energy values
and selects said encoding rate in accordance with said plurality of subband
8 energy values.

12. The apparatus of Claim 11 wherein said subband energy
2 calculator determines each of said plurality of subband energy values in
accordance with the equation:
4

$$\text{subband energy} = R_S(0) \cdot R_{hbp}(0) + 2 \cdot \sum_{i=1}^{L-1} R_S(i) \cdot R_{hbp}(i),$$

6   where L is the number taps in the lowpass filter $h_L(n)$,

8   where $R_S(i)$ is the autocorrelation function of the input signal, $S(n)$, and
     where R_{hL} is the autocorrelation function of a bandpass filter $h_{bp}(n)$.

     13.   The apparatus of Claim 11 further comprising threshold
2   calculator disposed between said subband energy calculator and said rate
     selector that receives said subband energy values and determines a set of
4   encoding rate threshold values in accordance with plurality of subband
     energy values.

     14.   The apparatus of Claim 13 wherein said threshold calculator
2   determines a signal to noise ratio value in accordance with said plurality of
     subband energy values.

     15.   The apparatus of Claim 14 wherein said threshold calculator
2   determines a scaling value in accordance with said signal to noise ratio
     value.

     16.   The apparatus of Claim 15 wherein threshold calculator
2   determines at least one threshold value by multiplying a background noise
     estimate by said scaling value.

     17.   The apparatus of Claim 11 wherein said rate selector compares
2   at least one of said plurality of subband energy values with at least one
     threshold value to determine said encoding rate.

     18.   The apparatus of Claim 16 wherein said rate selector compares
2   at least one of said plurality of subband energy values with said at least one
     threshold value to determine said encoding rate.

     19.   The apparatus of Claim 11 wherein said rate selector
2   determines a plurality of suggested encoding rates wherein each suggested
     encoding rate corresponds to each of said plurality of subband energy values
4   and wherein said rate selector determines said encoding rate in accordance
     with said plurality of suggested encoding rates.

     20.   An apparatus for determining an encoding rate for a variable
2   rate vocoder comprising:

a signal to noise ratio calculator that receives an input signal and
4 determining a signal to noise ratio value in accordance with said input
   signal;
6   rate selector that receives said signal to noise ratio value and selects
   said encoding rate in accordance with said signal to noise ratio value.

        21.   A method for determining an encoding rate for a variable rate
2 vocoder comprising the steps of:
        receiving an input signal;
4   determining a plurality of subband energy values in accordance with
   a predetermined subband energy computation format; and
6   determining said encoding rate in accordance with said plurality of
   subband energy values.

        22.   The method of Claim 21 wherein said step of determining a
2 plurality of subband energy values is performed in accordance with the
   equation:
4

$$\text{subband energy} = R_S(0) \cdot R_{h_{bp}}(0) + 2 \cdot \sum_{i=1}^{L-1} R_S(i) \cdot R_{h_{bp}}(i),$$

6
   where L is the number taps in the lowpass filter $h_L(n)$,
8 where $R_S(i)$ is the autocorrelation function of the input signal, $S(n)$, and
   where R_{hL} is the autocorrelation function of a bandpass filter $h_{bp}(n)$.

        23.   The method of Claim 21 further comprising the step of
2 determining a set of encoding rate threshold values in accordance with
   plurality of subband energy values.

        24.   The method of Claim 23 wherein said step of determining a set
2 of encoding rate threshold values determines a signal to noise ratio value in
   accordance with said plurality of subband energy values.

        25.   The method of Claim 24 wherein said step of determining a set
2 of encoding rate threshold values determines a scaling value in accordance
   with said signal to noise ratio value.

26. The method of Claim 25 wherein said step of determining a set
2 of encoding rate threshold values determines said rate threshold value by
   multiplying a background noise estimate by said scaling value.

27. The method of Claim 21 wherein said determining said
2 encoding rate compares at least one of said plurality of subband energy
   values with at least one threshold value to determine said encoding rate.

28. The method of Claim 26 wherein said step of said determining
2 said encoding rate compares at least one of said plurality of subband energy
   values with said at least one threshold value to determine said encoding
4 rate.

29. The method of Claim 21 further comprising the step of
2 generating a suggested encoding rate in accordance with each of said
   plurality of subband energy values and wherein said step of determining an
4 encoding rate selects one of said suggested encoding rates.

30. A method for determining an encoding rate for a variable rate
2 vocoder comprising the steps of:
        receiving an input signal;
4   determining a signal to noise ratio value in accordance with said
   input signal; and
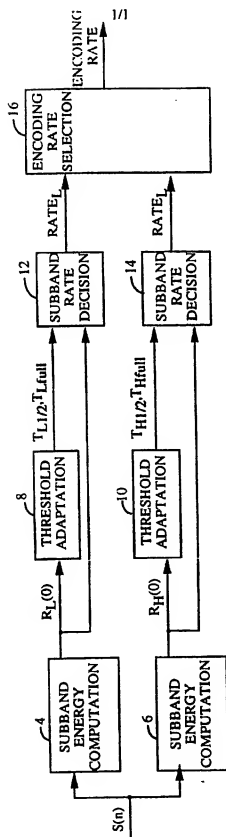6   determining said encoding rate in accordance with said signal to noise
   ratio value.

FIG. 1

A. CLASSIFICATION OF SUBJECT MATTER

G 10 L 3/00,G 10 L 7/04

According to International Patent Classification (IPC) or to both national classification and IPC 6

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

G 10 L,H 03 H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP, A, 0 167 364 (AMERICAN TELEPHONE AND TELEGRAPH COMPANY) 08 January 1986 (08.01.86), fig. 1; abstract; claims 1-9. --	1,3-8, 10,11, 20,21, 23-28, 30
A	EP, A, 0 190 796 (TELECOMMUNICATIONS RADIO-ELECTRIQUES ET TELEPHONIQUES T.R.T.) 13 August 1986 (13.08.86), fig. 4; abstract; claims 1-5. --	1-30
A	US, A, 5 054 075 (HONG et al.) 01 October 1991 (01.10.91), fig. 1,2; abstract;	1-30

[X] Further documents are listed in the continuation of box C.   [ ] Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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Date of the actual completion of the international search	Date of mailing of the international search report
10 November 1995	22 12 95

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+ 31-70) 340-2040, Tx. 31 651 epo nl, Fax (+ 31-70) 340-3016	BERGER e.h.

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Interna. .al Application No
PCT/US 95/09830

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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